

What is claimed is:

1. An image display device including a panel having a first electrode which extends in a first direction to write image data and a second electrode which extends in a second direction to select a display line, wherein a field period is divided into a plurality of sub-field periods that each have a predetermined luminance weight, and a gray-scale image for the field period is displayed by (a) writing sub-field image data of each sub-field period obtained by dividing input image data of the field period into the plurality of sub-field periods, into the panel through the first electrode and the second electrode, and (b) sustaining an illumination state of ON or OFF in each cell for each sub-field period using luminance equivalent to a luminance weight of each sub-field period, based on the written sub-field image data, the image display device comprising

an image changing unit for changing a part of sub-field image data of a predetermined sub-field period, so that a total number of charges and discharges performed on the first electrode when writing the sub-field image data becomes smaller.

2. An image display device including a panel having a first electrode which extends in a first direction to write image data and a second electrode which extends in a second direction to select a display line, wherein a field

5 period is divided into a plurality of sub-field periods
6 that each have a predetermined luminance weight, and a
7 gray-scale image for the field period is displayed by (a)
8 writing sub-field image data of each sub-field period
9 obtained by dividing input image data of the field period
10 into the plurality of sub-field periods, into the panel
11 through the first electrode and the second electrode, and
12 (b) sustaining an illumination state of ON or OFF in each
13 cell for each sub-field period using luminance equivalent
14 to a luminance weight of each sub-field period, based on
15 the written sub-field image data, the image display device
16 comprising

17 an image changing unit for changing a part of sub-field
18 image data of a predetermined sub-field period, so that
19 a total amount of power supplied through the first electrode
20 when writing the sub-field image data becomes smaller.

1 3. An image display device including a panel having
2 a first electrode which extends in a first direction to
3 write image data and a second electrode which extends in
4 a second direction to select a display line, wherein a field
5 period is divided into a plurality of sub-field periods
6 that each have a predetermined luminance weight, and a
7 gray-scale image for the field period is displayed by (a)
8 writing sub-field image data of each sub-field period
9 obtained by dividing input image data of the field period
10 into the plurality of sub-field periods, into the panel

11 through the first electrode and the second electrode, and
12 (b) sustaining an illumination state of ON or OFF in each
13 cell for each sub-field period using luminance equivalent
14 to a luminance weight of each sub-field period, based on
15 the written sub-field image data, the image display device
16 comprising

17 an image changing unit for changing a part of
18 sub-field image data of a predetermined sub-field period,
19 so that adjacent cells in the first direction, which
20 correspond to the part of the sub-field image data, are
21 uniformly one of ON and OFF in the predetermined sub-field
22 period.

23 4. An image display device including a panel having
24 a first electrode which extends in a first direction to
25 write image data and a second electrode which extends in
26 a second direction to select a display line, wherein a field
27 period is divided into a plurality of sub-field periods
28 that each have a predetermined luminance weight, and a
29 gray-scale image for the field period is displayed by (a)
30 writing sub-field image data of each sub-field period
31 obtained by dividing input image data of the field period
32 into the plurality of sub-field periods, into the panel
33 through the first electrode and the second electrode, and
34 (b) sustaining an illumination state of ON or OFF in each
35 cell for each sub-field period using luminance equivalent
36 to a luminance weight of each sub-field period, based on

15 the written sub-field image data, the image display device
16 comprising

17 an image changing unit for changing, when a part of
18 sub-field image data of a predetermined sub-field period
19 has a higher spatial frequency than a predetermined value,
20 the part of the sub-field image data so as to decrease the
21 spatial frequency, while keeping average luminance of the
22 part of the sub-field image data in the entire field period,
23 within a certain range.

5. An image display device including a panel having
a first electrode which extends in a first direction to
write image data and a second electrode which extends in
a second direction to select a display line, wherein a field
period is divided into a plurality of sub-field periods
that each have a predetermined luminance weight, and a
gray-scale image for the field period is displayed by (a)
writing sub-field image data of each sub-field period
obtained by dividing input image data of the field period
into the plurality of sub-field periods, into the panel
through the first electrode and the second electrode, and
(b) sustaining an illumination state of ON or OFF in each
cell for each sub-field period using luminance equivalent
to a luminance weight of each sub-field period, based on
the written sub-field image data, the image display device
comprising

an image changing unit for changing, when a part of

18 sub-field image data of a predetermined sub-field period
19 has a higher spatial frequency than a predetermined value,
20 the part of the sub-field image data so that

21 (a) cells corresponding to pixels which form the part
22 of the sub-field image data are uniformly OFF in the
23 predetermined sub-field period, and uniformly one of ON
24 and OFF in a sub-field period having a smaller luminance
25 weight than the predetermined sub-field period, if a
26 luminance weight of the predetermined sub-field period is
27 not the smallest luminance weight of the plurality of
28 sub-field periods, and

29 (b) the cells corresponding to the pixels which form
30 the part of the sub-field image data are uniformly one of
31 ON and OFF in the predetermined sub-field period, if the
32 luminance weight of the predetermined sub-field period is
33 the smallest luminance weight.

1 6. The image display device of Claim 5,

2 wherein when at least three adjacent cells in the first
3 direction which correspond to the pixels that form the part
4 of the sub-field image data of the predetermined sub-field
5 period are inverted from each other, and if the luminance
6 weight of the predetermined sub-field period is not the
7 smallest luminance weight, the image changing unit changes
8 the part of the sub-field image data so that the cells
9 corresponding to the pixels which form the part of the
10 sub-field image data are uniformly OFF in the predetermined

11 sub-field period, and uniformly ON in the sub-field period
12 having the smaller luminance weight.

1 7. The image display device of Claim 5,
2 wherein if the luminance weight of the predetermined
3 sub-field period is the smallest luminance weight, the
4 image changing unit uses an auxiliary sub-field period
5 whose luminance weight is substantially one-half of the
6 smallest luminance weight, and changes the sub-field image
7 data so that cells corresponding to all pixels which form
8 the sub-field image data are uniformly OFF in the
9 predetermined sub-field period, and uniformly ON in the
10 auxiliary sub-field period.

1 8. The image display device of Claim 5,
2 wherein when at least three adjacent cells in the
3 first direction that correspond to the pixels which form
4 the part of the sub-field image data of the predetermined
5 sub-field period are inverted from each other, and if the
6 luminance weight of the predetermined sub-field period is
7 the smallest luminance weight, the image changing unit
8 changes the part of the sub-field image data so that the
9 cells corresponding to the pixels which form the part of
10 the sub-field image data are uniformly OFF in the
11 predetermined sub-field period.

1 9. The image display device of Claim 5,

2 wherein when at least three adjacent cells in the
3 first direction that correspond to the pixels which form
4 the part of the sub-field image data of the predetermined
5 sub-field period are inverted from each other, and if the
6 luminance weight of the predetermined sub-field period is
7 the smallest luminance weight, the image changing unit
8 changes the part of the sub-field image data so that the
9 cells corresponding to the pixels which form the part of
10 the sub-field image data are uniformly ON in the
11 predetermined sub-field period.

1 10. The image display device of Claim 5,
2 wherein when the part of the sub-field image data of
3 the predetermined sub-field period has the higher spatial
4 frequency than the predetermined value only in the first
5 direction, the image changing unit determines whether to
6 change the part of the sub-field image data, depending on
7 a proportion of a number of pixels which form the part of
8 the sub-field image data to a total number of pixels which
9 form the sub-field image data.

1 11. The image display device of Claim 10,
2 wherein the image changing unit does not change the
3 part of the sub-field image data, when the cells
4 corresponding to the pixels which form the part of the
5 sub-field image data are not inverted from each other in
6 the second direction.

1 12. The image display device of Claim 10,
2 wherein the image changing unit does not change the
3 part of the sub-field image data, when the part of the
4 sub-field image data has the higher spatial frequency only
5 in the second direction.

1 13. An image display device including a panel having
2 a first electrode which extends in a first direction to
3 write image data and a second electrode which extends in
4 a second direction to select a display line, wherein a field
5 period is divided into a plurality of sub-field periods
6 that each have a predetermined luminance weight, and a
7 gray-scale image for the field period is displayed by (a)
8 writing sub-field image data of each sub-field period
9 obtained by dividing input image data of the field period
10 into the plurality of sub-field periods, into the panel
11 through the first electrode and the second electrode, and
12 (b) sustaining an illumination state of ON or OFF in each
13 cell for each sub-field period using luminance equivalent
14 to a luminance weight of each sub-field period, based on
15 the written sub-field image data, the image display device
16 comprising

17 an image changing unit for changing, when a part of
18 sub-field image data of a predetermined sub-field period
19 which is no smaller than one-half of the sub-field image
20 data has a higher spatial frequency than a predetermined

21 value, the sub-field image data so that cells corresponding
22 to all pixels of the sub-field image data are uniformly
23 ON in the predetermined sub-field period, while keeping
24 average luminance of the sub-field image data in the
25 predetermined sub-field period, within a certain range.

A 1 14. The image display device of ^{claim 1} ~~one of Claims 1, 2,~~
2 ~~3, 4, 5, and 13,~~

3 wherein the image changing unit changes the part of
4 the sub-field image data or the sub-field image data, only
5 when the predetermined sub-field period has a smaller
6 luminance weight than a predetermined value.

A 1 15. The image display device of ^{claim 1} ~~one of Claims 1, 2,~~
2 ~~3, 4, 5, and 13,~~

3 wherein the image changing unit changes the part of
4 the sub-field image data or the sub-field image data, only
5 when an amount of power required to drive the first
6 electrode is greater than a predetermined value.

1 16. An image display device including a panel having
2 a first electrode which extends in a first direction to
3 write image data and a second electrode which extends in
4 a second direction to select a display line, wherein a field
5 period is divided into a plurality of sub-field periods
6 that each have a predetermined luminance weight, and a
7 gray-scale image for the field period is displayed by (a)

8 writing sub-field image data of each sub-field period
9 obtained by dividing input image data of the field period
10 into the plurality of sub-field periods, into the panel
11 through the first electrode and the second electrode, and
12 (b) sustaining an illumination state of ON or OFF in each
13 cell for each sub-field period using luminance equivalent
14 to a luminance weight of each sub-field period, based on
15 the written sub-field image data, the image display device
16 comprising:

17 image data storing means for storing sub-field image
18 data of each sub-field period;

19 pattern detecting means for reading sub-field image
20 data of a predetermined sub-field period from the image
21 data storing means, and detecting whether a part of the
22 read sub-field image data has a specific pattern that causes
23 a substantial increase in power consumption when writing
24 the sub-field image data; and

25 image changing means for, when the part of the
26 sub-field image data having the specific pattern is
27 detected by the pattern detecting means,

28 (a) reading the sub-field image data of the
29 predetermined sub-field period from the image data storing
30 means, changing the part of the sub-field image data so
31 that cells corresponding to pixels which form the part of
32 the sub-field image data are uniformly OFF in the
33 predetermined sub-field period, and storing the changed
34 sub-field image data back into the image data storing means,

35 and
36 (b) reading sub-field image data of a sub-field period
37 whose luminance weight is smaller than the predetermined
38 sub-field period from the image data storing means,
39 changing a corresponding part of the read sub-field image
40 data so that the cells corresponding to the pixels which
41 form the corresponding part of the sub-field image data
42 are uniformly ON in the sub-field period, and storing the
43 changed sub-field image data back into the image data
44 storing means.

17. An image display device including a panel having
a first electrode which extends in a first direction to
write image data and a second electrode which extends in
a second direction to select a display line, wherein a field
period is divided into a plurality of sub-field periods
that each have a predetermined luminance weight, and a
gray-scale image for the field period is displayed by (a)
writing sub-field image data of each sub-field period
obtained by dividing input image data of the field period
into the plurality of sub-field periods, into the panel
through the first electrode and the second electrode, and
(b) sustaining an illumination state of ON or OFF in each
cell for each sub-field period using luminance equivalent
to a luminance weight of each sub-field period, based on
the written sub-field image data, the image display device
comprising:

17 image data storing means for storing sub-field image
18 data of each sub-field period;

19 pattern detecting means for reading sub-field image
20 data of a predetermined sub-field period from the image
21 data storing means, and detecting whether a part of the
22 read sub-field image data has a specific pattern that causes
23 a substantial increase in power consumption when writing
24 the sub-field image data;

25 comparing means for comparing, when the part of the
26 sub-field image data having the specific pattern is
27 detected by the pattern detecting means, a number of pixels
28 which form the part of the sub-field image data with a
29 predetermined number;

30 image changing means for (a) reading, when the number
31 of pixels is no smaller than the predetermined number, the
32 sub-field image data of the predetermined sub-field period
33 from the image data storing means, (b) changing the read
34 sub-field image data so that cells corresponding to all
35 pixels of the sub-field image data are uniformly ON in the
36 predetermined sub-field period, and (c) storing the
37 changed sub-field image data back into the image data
38 storing means; and

39 luminance controlling means for changing a luminance
40 weight of the predetermined sub-field period, so that
41 average luminance of the sub-field image data in the
42 predetermined sub-field period is kept within a certain
43 range.

1 18. A computer program for processing image data of
2 a field period, wherein the field period is divided into
3 a plurality of sub-field periods that each have a
4 predetermined luminance weight, and a gray-scale image for
5 the field period is displayed by (a) writing sub-field image
6 data of each sub-field period obtained by dividing input
7 image data of the field period into the plurality of
8 sub-field periods, and (b) sustaining an illumination
9 state of ON or OFF in each cell in a panel for each sub-field
10 period based on the written sub-field image data, the
11 computer program comprising

12 an image changing step for

13 changing a part of sub-field image data of a
14 predetermined sub-field period which has a specific
15 pattern that causes a substantial increase in power
16 consumption when writing the sub-field data, so that cells
17 corresponding to pixels which form the part of the sub-field
18 image data are uniformly OFF in the predetermined sub-
19 field period, and

20 changing a corresponding part of sub-field image data
21 of a sub-field period having a smaller luminance weight
22 than the predetermined sub-field period, so that the cells
23 corresponding to the pixels which form the corresponding
24 part of the sub-field image data are uniformly ON in the
25 sub-field period.

1 19. A computer program for processing image data of
2 a field period, wherein the field period is divided into
3 a plurality of sub-field periods that each have a
4 predetermined luminance weight, and a gray-scale image for
5 the field period is displayed by (a) writing sub-field image
6 data of each sub-field period obtained by dividing input
7 image data of the field period into the plurality of
8 sub-field periods, and (b) sustaining an illumination
9 state of ON or OFF in each cell in a panel for each sub-field
10 period based on the written sub-field image data, the
11 computer program comprising
12 an image changing step for changing sub-field image
13 data of a predetermined sub-field period which has a
14 specific pattern that causes a substantial increase in
15 power consumption when writing the sub-field data, so that
16 cells corresponding to pixels which form the sub-field
17 image data are uniformly ON in the predetermined sub-field
18 period, while keeping average luminance of the sub-field
19 data in the predetermined sub-field period within a certain
20 range.

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